National Aeronautics and Space Administration

The Lifetime Surveillance of Astronaut Health Newsletter

Volume 25, Issue 1

Editor's Note: We hope you are all doing well during this unprecedented time in our history. This edition of the LSAH Newsletter looks at the most recent updates to the TREAT Astronauts Act, as well as how to make a behavioral telehealth appointment with the JSC Clinic during the COVID-19 pandemic. We dive into the history of LSAH in the last three decades, and peer into the future of the Artemis program while remembering the great strides taken from the Apollo era.

A Message from the JSC Clinic!

As a reminder, your routine medical evaluation now includes a dedicated behavioral health session with our Clinical Neuropsychologist, Dr. Carmen Pulido. The initial session will take approximately 1.5 hours, and will include a review of your developmental, occupational, and medical history. In response to COVID-19 and the current limitations on travel, we have this service available virtually! For a behavioral telehealth appointment with Dr. Pulido, please contact the JSC Flight Medicine Clinic at 281-483- 7999 during normal business hours. Making a behavioral telehealth appointment will not affect your ability to visit the JSC Clinic for your routine physical and other health appointments. Please note, we do not currently have multidisciplinary telehealth services available with other Clinic staff. If you already met with Dr. Pulido as part of your annual visit, you can meet with her again if desired.

We hope that you and your family are healthy and safe, and we look forward to hearing from you.

Sincerely,
Ronak V. Shah, DO, MBA, MPH Medical Director of Clinical Services

Carmen Pulido, Ph.D., Clinical Neuropsychologist
Mobile 832-284-5125, Carmen.pulido@nasa.gov

Nov. 15, 2019 - NASA astronaut Andrew Morgan waves as he is photographed during the first spacewalk to repair the Alpha Magnetic Spectrometer, a cosmic particle detector on the International Space Station.

LSAH: Looking Back, Moving Forward

Mary Wear, Ph.D. and Jacqueline Charvat, Ph.D.

The National Aeronautics and Space Act of 1958 established NASA and included a mandate to monitor the effects of exposure to the space environment on astronaut health.[1] The first NASA astronauts were selected in 1959; as of 2018, NASA had selected 350 individuals to serve in the Astronaut Corps. Members of this group are chosen based on stringent health, skills, and educational requirements.[2] Astronauts face unique occupational exposures; spaceflight poses known and unknown risks to human health. Health risks for astronauts may have short-term and long-term physical and psychological consequences. To understand the effects of spaceflight on the long-term health of the Astronaut Corps, NASA developed longitudinal research and occupational surveillance programs, including the Longitudinal Study

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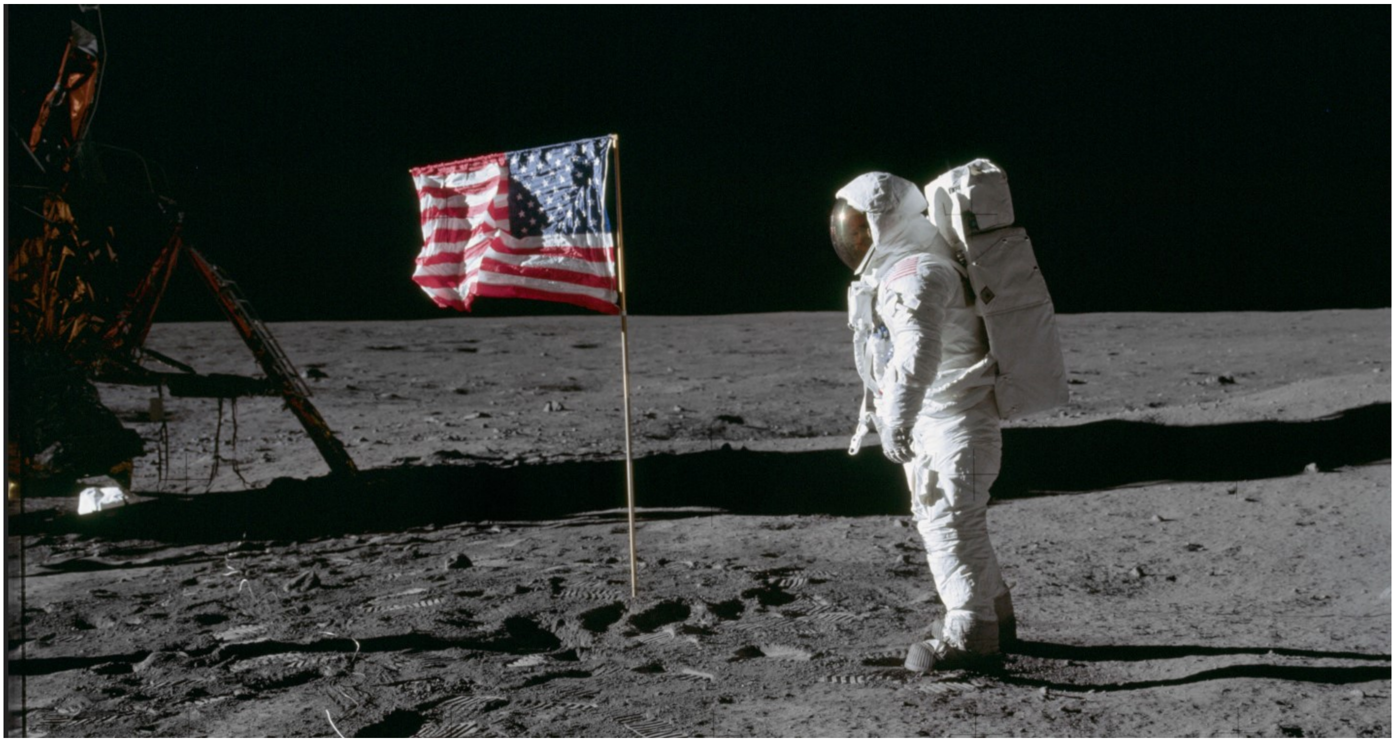
LSAH: Looking Back, Moving Forward continued



Astronaut Edwin E. Aldrin Jr., lunar module pilot, stands beside the deployed United States flag during Apollo 11 EVA on the lunar surface. The Lunar Module "Eagle" is on the left. The footprints of the astronauts are visible in the soil of the moon.

of Astronaut Health and Lifetime Surveillance of Astronaut Health. Since the 1980's these programs have been continuously reevaluated and improved in several distinct phases to meet higher standards of efficiency, internal validity, and ultimately, protection of the Astronaut Corps.

Phase I

The Longitudinal Study of Astronaut Health, Phase I, was established to examine the incidence of acute and chronic morbidity and mortality of astronauts and was conducted during the 1980s. Phase I described the health risks associated with astronaut occupational exposures, and compared them to the risks for a group of civil service employees of Johnson Space Center (JSC). The comparison group was individually matched to the first 178 astronauts at a 5:1 ratio. The matching criteria included sex, age, body mass index (BMI), smoking habits, length of service at JSC, and exercise habits (if this information was available).[3]

In 1989, NASA enlisted an external panel of epidemiologists and statisticians to evaluate Phase I. The panel identified a number of limitations including a biased selection of comparisons and uneven data collection between the two groups. The panel recommended that the study design be strengthened to mitigate these limitations and the first phase of the longitudinal study ended in 1991.[4]

Phase II

NASA began Phase II of the longitudinal research study in 1992. Phase II included a 3:1 ratio of JSC civil service employees to serve as a comparison population to astronauts. The JSC civil service comparison population was considered a healthy worker cohort that was matched by selection year, age, sex, and BMI. The retrospective match was performed for the entire astronaut population, including deceased and retired astronauts. A detailed description of the retrospective matching process is provided elsewhere.[5] From 1992 to 2000, a prospective match of comparison subjects to astronauts was made as each astronaut selection class was announced.

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LSAH: Looking Back, Moving Forward continued

The Phase II study had a number of strengths. The data collected were unique among longitudinal studies, collecting a substantial volume of medical data based on standardized testing at regular intervals over a period of up to 50 years. This database was used to populate the JSC Electronic Medical Record when it was first implemented in 1999. Retired astronauts returned for annual follow-up examinations at a rate of 65-70% while the comparison subjects had a 62-65% return rate. The Phase II study generated an annual cancer incidence report and a number of other internal reports and analyses to inform NASA's space medicine program. Phase II study results also informed internal NASA policy and decision making, and supported several other contributions to the greater science community.[6]

It is difficult to design a perfect case-control study and the Phase II study had some challenges. The most critical challenge was that the limited matching criteria resulted in significant differences between the astronaut and comparison populations. Differences between the populations include dissimilar health status at selection. For instance, the members of the comparison population were not excluded based on pre-existing medical conditions such as diabetes, whereas rigorous medical screening performed during astronaut selection would have excluded astronauts with these conditions. In addition, different exam intervals between groups (bi-annually for the comparison population; annually for astronauts), and differences in laboratory testing performed (astronauts received a wider battery of tests on a more frequent schedule) created disparities in the population data.

Noting the challenges in Phase II, NASA sought external advice and commissioned the Institute of Medicine (IOM) to consider approaches to space medicine in preparation for long duration space travel and to evaluate the Phase II program. The IOM panels issued two reports, "Committee on Creating a Vision for Space Medicine During Travel Beyond Earth Orbit"[7], and "A Review of NASA's Longitudinal Study of Astronaut Health"[4] The IOM panels recommended that NASA establish an occupational surveillance program and provide long-term healthcare. The IOM cited other government-sponsored occupational surveillance programs such as the Department of Energy, Veteran's Administration, and Department of Defense as models to follow. The Phase II research study officially ended in May 2010.

The Lifetime Surveillance of Astronaut Health (LSAH) Occupational Health Program

In accordance with the IOM recommendations, NASA transitioned the Longitudinal Study of Astronaut Health into an occupational health program, the Lifetime Surveillance of Astronaut Health (LSAH). This program treats the Astronaut Corps as a worker population with unique occupational exposures. The JSC Flight Medicine Clinic collects the medical data and LSAH conducts analysis of the data. Given the small number of astronauts who have flown in space, every possible piece of data is necessary to understand the unique health implications of spaceflight on the human body. However over 70% of health data is in narrative text format, making preparation and analysis of these data labor intensive. In 2019, LSAH epidemiologists began using clinical text extraction (CTE) software to reduce the time to process and extract critical information from text data. These data help medical staff, epidemiologists and researchers better understand the association between medical events, medication use, symptoms reported, and the association to spaceflight.

TREAT Astronauts Act

On March 21, 2017, President Trump signed the National Aeronautics and Space Administration Transition Authorization Act of 2017[8] with bipartisan support. Included was a new initiative: To Research, Evaluate, Assess, and Treat (TREAT) Astronauts Act. The TREAT Astronauts Act, sometimes referred to as simply TREAT, significantly expands NASA's authority. For NASA astronauts and payload specialists who have spaceflight experience, NASA will provide monitoring, diagnosis and treatment for spaceflight-associated conditions. NASA will, as a secondary payer, cover any medical costs associated with the monitoring, diagnosis

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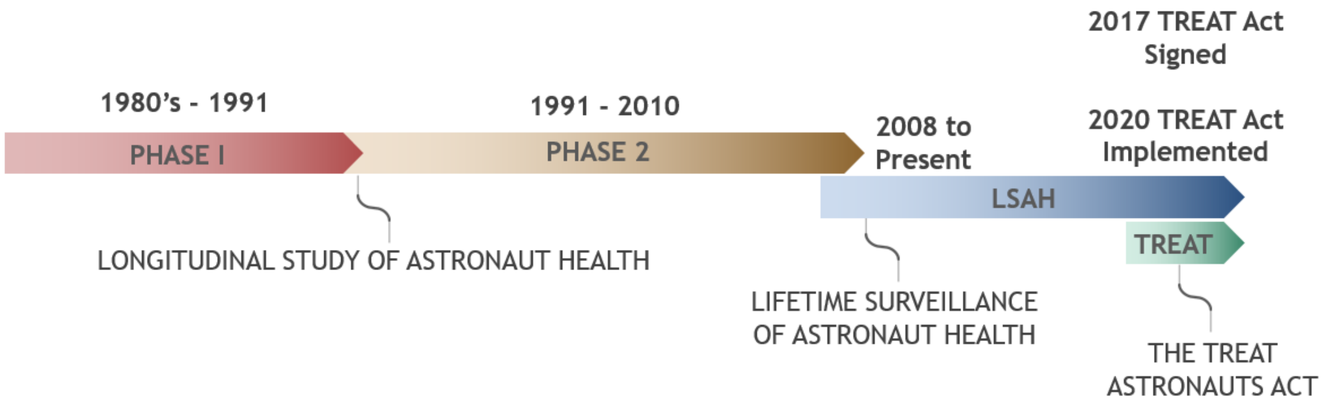
LSAH: Looking Back, Moving Forward continued



and treatment of a spaceflight-associated condition. This includes deductibles, coinsurance, copayments, and similar charges, but excludes insurance premiums. Former U.S. astronauts and payload specialists who believe they have a spaceflight-associated condition must first seek treatment from the Department of Defense Military Health System, the Department of Labor Office of Workers' Compensation Programs Division of Federal Employees' Compensation, or through third party payers, as applicable. The JSC Flight Medicine Clinic will assist former U.S. Government astronauts and payload specialists with these processes as well as filing a claim with NASA.

On March 18, 2020, an interim final rule, 14 CFR 1241, was published in the Federal Register, 85 FR 15352-15359. This rule describes how the TREAT program will be implemented. A TREAT Astronauts Act Board (TAAB) has been established with two purposes: 1) Determine the association between occupational medical and psychological conditions and training for or exposure to the spaceflight environment, and 2) Determine the association between select occupational medical and psychological conditions and astronaut population training or exposure to the spaceflight environment. Based on these determinations, an Index of Medical Conditions Related to Spaceflight will be created. The TAAB also has two responsibilities: 1) Determine if a medical claim meets the criteria to be designated as a spaceflight-associated condition, based on clinical and exposure history, biological plausibility, and reasoned medical opinion by a panel of aerospace physicians, and 2) Identify latent medical and psychological conditions associated with hazards of the astronaut occupation at a population level. The TAAB may also recommend that additional monitoring is necessary, based on each individual's exposure history and medical needs. A provision has been added specifically for NASA to also request autopsies, as part of monitoring, as they may contribute substantially to the knowledge of spaceflight physiology or pathology. For more information about TREAT, see the Human Health & Performance Directorate TREAT Astronauts Act website: https://www.nasa.gov/hhp/treat-act, and the Interim rule posted in the Federal Register on March 18, 2020: https://www.govinfo.gov/content/pkg/FR-2020-03-18/pdf/2020-04784.pdf.

NASA has long supported the health and well-being of the Astronaut Corps. The Longitudinal Study of Astronaut Health research study provided a core characterization of the Astronaut Corps. The current Lifetime Surveillance of Astronaut Health occupational surveillance program continues to increase our understanding of the health effects of spaceflight. TREAT provides additional monitoring, diagnosis and treatment of spaceflight-associated conditions.

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Continued from page 4

LSAH: Looking Back, Moving Forward continued

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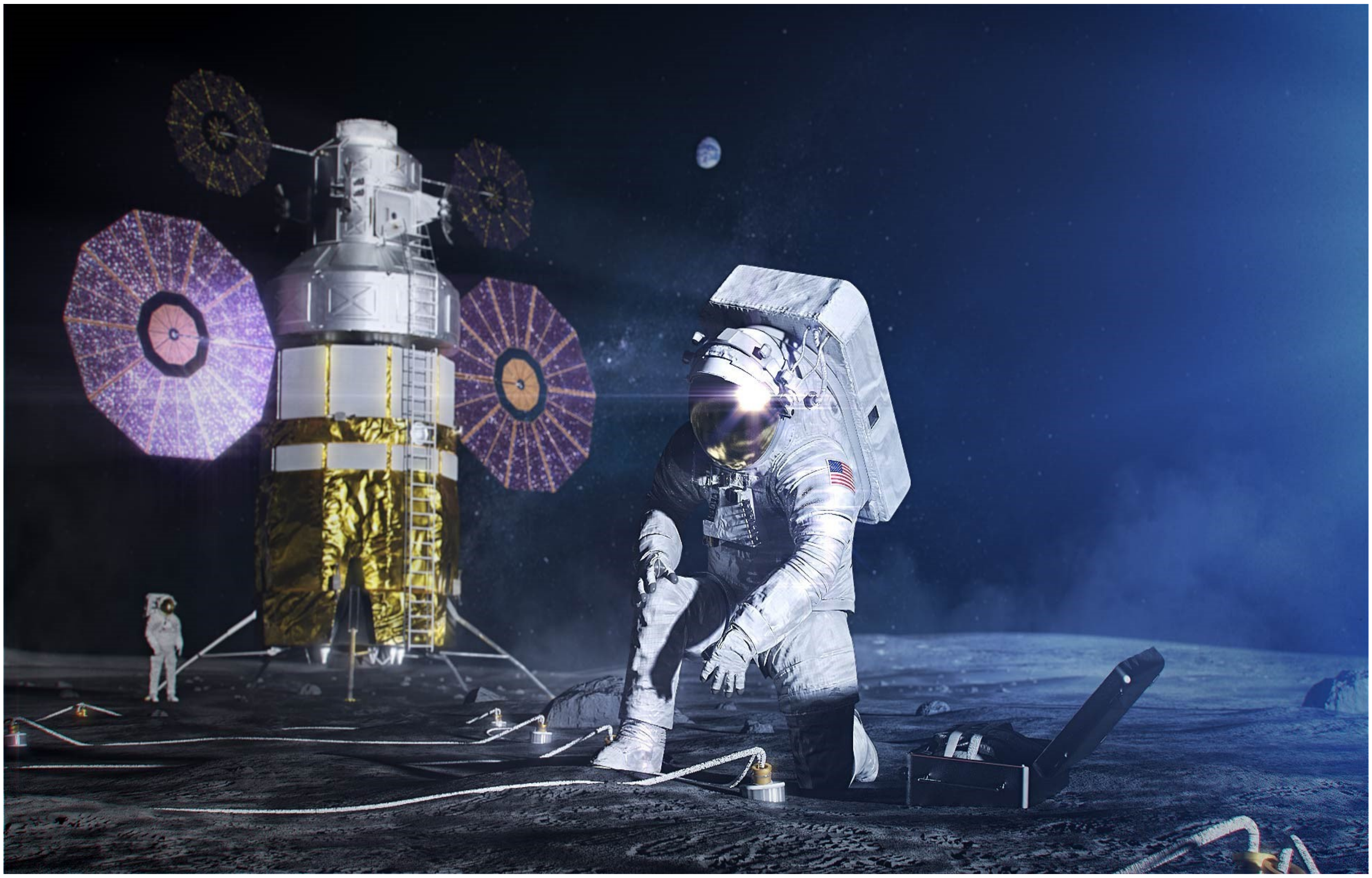
March 18, 2019 - NASA astronaut Anne McClain assists fellow NASA astronauts Christina Koch (left) and Nick Hague as they verify their U.S. spacesuits fit properly ahead of a spacewalk.

May 18, 2009 - Astronaut John Grunsfeld, STS-125 mission specialist, positioned on a foot restraint on the end of Atlantis' remote manipulator system, and astronaut Andrew Feustel (top center), mission specialist, participate in the mission's fifth and final session of extravehicular activity as work continues to refurbish and upgrade the Hubble Space Telescope.

Do you have a suggestion for a newsletter article, or news and photos you would like to share? We'd love to hear about it! Send suggestions, comments, or questions to alexandra.l.newport@nasa.gov.

Apollo to Artemis: Mining 50-Year-Old Records to Inform Future Human Lunar Landing Systems

Devan Petersen, Jacqueline Charvat, Jeffrey Somers, James Pattarini, Michael Brian Stenger, Mary Van Baalen, S.M.C. Lee



A futuristic rendering created by NASA depicts an Artemis mission and crew landing on the surface of the moon or Mars.

As NASA prepares to send the first woman and next man to the lunar surface in 2024, we are turning to the lessons learned during the first missions to the Moon over fifty years ago. Most of the medical information available from the Apollo missions is stored in paper records archived at the Johnson Space Center in NASA's Early Program Medical Records Inventory. Epidemiologists from the Lifetime Surveillance of Astronaut Health reviewed more than 5,000 pages of these records, mining astronauts' medical records, results from stand and lower body negative pressure tests, reports from the biomedical engineers and flight surgeons, and medical debrief transcripts to understand what today's astronauts should expect when they return to the Lunar surface.

In particular, NASA is trying to understand how best to design the landing systems for Lunar missions. Similar to the Apollo program, the Artemis landers will have limited mass and volume, which may mean that astronauts are standing during the

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Apollo to Artemis continued

lunar descent. If, like the Apollo astronauts, Artemis's astronauts are standing for lunar descent and ascent, they will experience +Gz (head-to-foot) accelerations during capsule accelerations. We don't yet know how crew that have been living in microgravity for longer than a day or two will respond to this type of acceleration.

The data in the Early Program Medical Records Inventory provides unique insight into the experience of the Apollo astronauts during the six missions that landed on the moon. The records contain limited but valuable data on cardiovascular and other symptoms that may provide insights to the physiological stress associated with this human landing system design.

Onboard the lunar modules, there was only one set of electrocardiogram sensors available for the transmission of biomedical data. Only the heart rates of the Commanders were recorded, and no blood pressure data were obtained. Few detailed notes remain regarding the condition of the crew. Despite challenges with retrieving the limited data, the data mined from the results of this effort provided a unique source of information to inform design choices for Artemis. It also serves as a reminder of the importance of collecting and archiving human health data. Continued efforts to extract data from historical sources may help the agency in assessing risks associated with future endeavors.

July 16, 1969 - The 363-feet tall Apollo 11 space vehicle was launched from KSC. Onboard Apollo 11 are astronauts Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. Aldrin Jr., lunar module pilot.

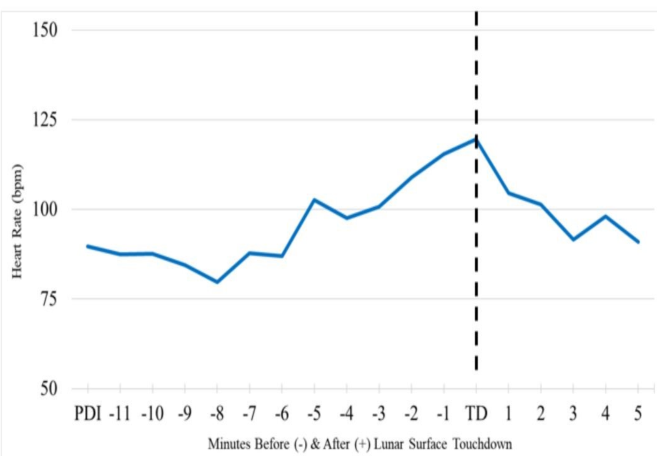

Figure 1.

Average heart rate response from Apollo Commanders from powered descent initiation (PDI) to touchdown (TD) on the lunar surface.

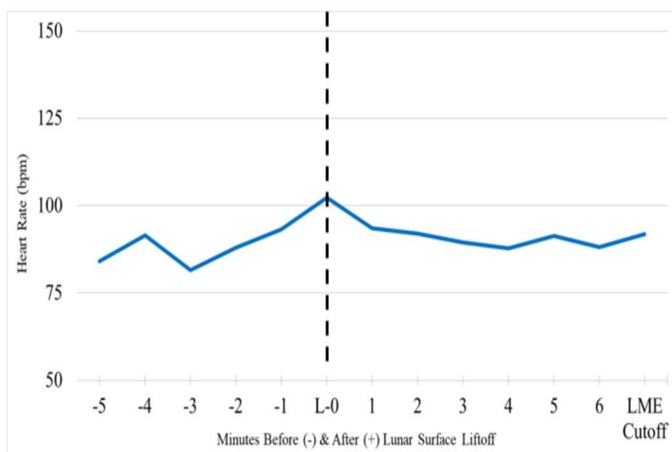

Figure 2.

Average heart rate response from Apollo Commanders before and during ascent from the lunar surface to lunar module engine (LME) cutoff.

Publications Corner (2019-Present)

Attached are publications related to LSAH data requests and other papers that may be of interest. For your convenience, each publication has a link to take you directly to the abstract or publication online. For papers not available via open source, the corresponding author may be able to provide you with a copy.

2019

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Prolonged Microgravity Affects Human Brain Structure and Function. Roberts DR, Asemani D, Nietert PJ, et al. AJNR Am J Neuroradiol. 2019;40(11):1878–1885; http://www.ajnr.org/content/early/2019/10/17/ajnr.A6249.abstract

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The second edition of ***Principles of Clinical Medicine for Space Flight*** (New York: Springer, 2019. 939 p.) has recently been published. Edited by Michael Barratt, Ellen Baker, and the late Sam Pool, the 30 chapters in this edition incorporate knowledge learned through continuous human presence aboard the International Space Station since the first edition was published in 2008. The book is available at: https://link.springer.com/book/10.1007/978-1-4939-9889-0

2020

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News and Notes

Recent News: Class of 2020 NASA Astronauts Graduate with Eye on Artemis Missions

Cheryl Warner and Megan Sumner

A new class of astronauts graduated on Jan. 10, 2020. They joined the active astronaut corps, beginning careers in exploration that may take them to the International Space Station, on missions to the Moon under the Artemis program, or someday, Mars.

NASA welcomed 11 new astronauts to its ranks January 10, 2020, along with the two new CSA astronauts. The new astronauts successfully completed more than two years of required basic training and are the first to graduate since the agency announced its Artemis program. "These individuals represent the best of America, and what an incredible time for them to join our astronaut corps," said NASA Administrator Jim Bridenstine at the agency's Johnson Space Center in Houston, where the graduation ceremony took place. "2020 will mark the return of launching American astronauts on American rockets from American soil, and will be an important year of progress for our Artemis program and missions to the Moon and beyond." During the ceremony, each new astronaut received a silver pin, a tradition dating back to the Mercury 7 astronauts, who were selected in 1959. They will receive a gold pin once they complete their first spaceflights. This was the first public graduation ceremony for astronauts the agency has ever hosted, and Sens. John Cornyn and Ted Cruz of Texas were among the speakers at the event. A huge congratulations to NASA graduates Kayla Barron, Zena Cardman, Raja Chari, Matthew Dominick, Bob Hines, Warren Hoburg, Johnny Kim, Jasmin Moghbeli, Loral O'Hara, Frank Rubio and Jessica Watkins, as well as CSA graduates Joshua Kutryk and Jennifer Sidey-Gibbons. Find their official astronaut biographies here.

FYI

Did you move? New Email address? Remember to update us so we can continue to send you the LSAH Newsletter, LSAH Invitational physical exam letters and any other news we may need to share with you. Contact Denise Patterson at 281-244-5195 or denise.a.patterson@nasa.gov.

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